

## The Genus *Lepidozona*

(Mollusca : Polyplacophora)

### in the Temperate Eastern Pacific, Baja California to Alaska, with the Description of a New Species

BY

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(5 Plates; 3 Text figures)

THE GENUS *Lepidozona* Pilsbry, 1892, is remarkably well represented in the eastern Pacific. In addition to the 6 species recognized in the Panamic province (FERREIRA, 1974), some twenty other nominal species of chitons in the northeastern Pacific have been assigned to the genus.

This study continues previous work on the tropical eastern Pacific *Lepidozona* (FERREIRA, *l.c.*), and extends the review of the genus to the temperate waters of the Californian, Oregonian, and Aleutian provinces which, covering some 6000 km of coast from Baja California to Alaska, lie between the parallels 23°N and 60°N approximately. The investigation is based upon the examination of material in the collections of the California Academy of Sciences (CAS), Los Angeles County Museum of Natural History (LACM), Allan Hancock Foundation (AHF), University of Southern California (UCLA), San Diego Museum of Natural History (SDNH), United States National Museum of Natural History (USNM), Academy of Natural Sciences of Philadelphia (ANSP), and in the private collections of Allyn G. Smith (AGS), John H. Himmelman, S. Stillman Berry (SSB), Salle Crittenden, George A. Hanselman, Glenn & Laura Burghardt, and myself (AJF).

From the data, 8 species of *Lepidozona* are recognized in the temperate northeastern Pacific, one new to science:

*Lepidozona cooperi* (Dall, 1879)

*Lepidozona guadalupensis* Ferreira, spec. nov.

*Lepidozona mertensii* (Middendorff, 1847)

*Lepidozona pectinulata* (Carpenter in Pilsbry, 1893)

*Lepidozona retiporosa* (Carpenter, 1864)

*Lepidozona scabricostata* (Carpenter, 1864)

*Lepidozona sinudentata* (Carpenter in Pilsbry, 1892)

*Lepidozona willetti* (Berry, 1917)

POLYPLACOPHORA de Blainville, 1816

Neoloricata Berghenayn, 1955

ISCHNOCHITONINA Berghenayn, 1930

ISCHNOCHITONIDAE Dall, 1889

*Lepidozona* Pilsbry, 1892

As redescribed (FERREIRA, 1974: 163): Small to medium size chitons. End valves and lateral areas with radial ribs, usually pustulose or graniferous; central areas with longitudinal riblets, often cross-ribbed (latticed), the jugal tract usually diverging forwardly to form a wedge-like feature on the second valve. Articulation usually white; end valves with around 10 slits; intermediate valves uni-slitted; sutural laminae sharp; eaves not spongy; sinus well defined. Girdle of imbricated, medium size scales, usually strongly convex, striated, and mammillated.

Type species: *Chiton mertensii* Middendorff, 1847, by OD, PILSBRY, 1892: 125.

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*Lepidozona mertensii* (Middendorff, 1847)

(Figures 1, 2, 20, 21, 34)

*Chiton Mertensii* MIDDENDORFF, 1847a: 118*Chiton (Stenosemus) Mertensii*, MIDDENDORFF, 1847b: 125 - 127, tbl. 14, figs. 1 - 3*Lepidopleurus mertensii*, COOPER, 1867: 22 - DALL, 1879: 332*Ischnochiton mertensii*, PILSBRY, 1892: 125 - 126, pl. 26, figs. 20 - 26, (in section *Lepidozona*); 1898, 50: 288 - HEATH, 1904, 56: 257 - 259, textfig. B; 1905, 29: 391 - NIERSTRASZ, 1905, 48: 82 - BERRY, 1907, 21 (5): 51 - DALL, 1921, 112: 192 (in section *Lepidozona*) - OLDROYD, 1924: 191 - 192; 1927: 280 - 281 - JOHNSON & SNOOK, 1927: 564 - SIMROTH & HOFFMAN, 1929: 314 - CHACE & CHACE, 1930, 44 (1): 8; 1933, 46 (4): 124 - FRASER, 1932, 3rd ser., 26 (5): 65 - LELOUP, 1940: 10 - 12, figs. 25 - 33 - WILLETT, 1941: 185 - 186, fig. 1 - ANDREWS, 1945, 26: 24 - 37 - LA ROCQUE, 1953: 12 (in section *Lepidozona*) - LIGHT, et al., 2nd ed., 1954: 217 - 218 - THOMPSON & CHOW, 1955, 3 (suppl.): 20 - 39 - THORPE, 1962, 4 (4): 205, 207 - HELFMAN, 1968, 10 (3): 290 - 291*Ischnochiton (Lepidozona) mertensii*, BERRY, 1917, 7 (10): 26; 1922, 11 (18): 475 - 476, pl. 10, figs. 7 - 12 (fossil); 1927, 17: 164 - A. G. SMITH, 1947: 18 - A. G. SMITH & GORDON, 1948, 26 (8): 208 - ABBOTT, 1954: 322 - 323*Lepidozona mertensii*, Is. TAKI, 1938: 390 - 392, pl. 14, fig. 6; pl. 29, figs. 1 - 6; pl. 30, figs. 6 - 9; pl. 31, figs. 9, 10; 1962: 41 - RICKETTS & CALVIN, 1962: 89, and frontispiece (in color) - Iw. TAKI, 1964: 409 - BURGHARDT & BURGHARDT, 1969: 22, pl. 2, fig. 28 (in color) - RICE, 1971: 20, pl. 4, fig. 9 (in color) - A. G. SMITH in LIGHT, et al., 3rd ed., 1974: 463, 465 - ABBOTT, 1974: 395, fig. 4639

**Diagnosis:** Chitons of medium size (up to about 4 cm); color in reddish tones, uniformly, speckled, or with one or two transversal bands of a cream color. End valves and lateral areas with radial rows of robust tubercles defining virtual "ribs" not separated by sulci; central areas with longitudinal riblets cross-ribbed for a latticed effect. Girdle scales convex, often mammillated, obsoletely striated.

**Type Material:** Lost, or never designated. OLDROYD (1927: 281) stated "Type in Academy, St. Petersburg"; but an inquiry to the Academy of Sciences of the USSR, Leningrad, revealed that "Middendorff's specimens are absent in the Academy collection" (Dr. B. Sirenko, *in litt.*,

November 12, 1975). Since Middendorff's original specimens cannot be located, a neotype specimen from the original locality, Fort Ross, California, is designated, described, and illustrated, in accordance with Article 75 of the International Code of Zoological Nomenclature (ICZN), London, 1964.

The neotype is part of a lot of 14 specimens collected intertidally, 800 m south of Fort Ross (38°30.7' N, 123°14.0' W), Sonoma County, California, by Dr. James H. McLean, on December 28, 1963. The neotype, partly disarticulated, (LACM 1855), and specimen from the neotype lot (LACM 1856), are placed in the repository of the Los Angeles County Museum of Natural History. Other specimens from the neotype-lot are deposited at the California Academy of Sciences (CASIZ, Type Series no. 701), Zoological Institute of the Academy of Sciences in Leningrad, USSR (no. 1861), Laboratoire de Malacologie, Museum National d'Histoire Naturelle, Paris, and in Iwao Taki Collection, Japan.

**Type Locality:** "California," as originally given by MIDDENDORFF (1847a). In a subsequent report, MIDDENDORFF (1847b) added "Kalifornien, namentlich die früher Russ. Kolonie Ross. Mertens hatte das Thier dort erbeutet." In view of this statement, the type locality is here restricted to the presently called Fort Ross (38°31' N, 123°14' W), Sonoma County, California.

**Original Description:** First read publicly on December 11, 1846, but published only on April 20, 1847: "*Chiton testa externa ovali elevata carinata opaca, aspera, fusco-cinerea; valva antica valvae ultimae area postica, valvarum denique intermediarum areis lateralibus radiatim expresse granuloscabris. Valvarum intermediarum areis centralibus et valvae ultimae area antica longitudinaliter exsculpte-costatis, costis medianis postica versus dichotomis; costarum interstitia lamellis erectis transversis in loculamenta dissepita. Valva antica dentibus marginalibus 13 et radiis granuloscabris 26. Valva ultima margine postico convexo dentibus 13 et radiis granuloscabris 20. Valvarum intermediarum radiis granuloscabris quinque. Pallium marginale epidermide fuscocinerea, squamisque aspera, obtectum. Squamae hae in series oblique decurrentes ordinatae. Branchiarum series ab initio secundae*

## Explanation of Figures 1 to 6

Figure 1: *Lepidozona mertensii*. Neotype (in text), 33.0 mm long (LACM 1855)

Figure 2: *Lepidozona mertensii*. Neotype. Close-up of lateral areas

Figure 3: *Lepidozona cooperi*. 28.2 mm long, Bolinas, California (CASG 30915)

Figure 4: *Lepidozona cooperi*. Close-up of specimen in Figure 3 to show detail of lateral areas

Figure 5: *Lepidozona pectinulata*. 16.3 mm long, San Diego, California (ANSP 118664)

Figure 6: *Lepidozona pectinulata*. Close-up of specimen in Figure 5 to show detail of lateral areas

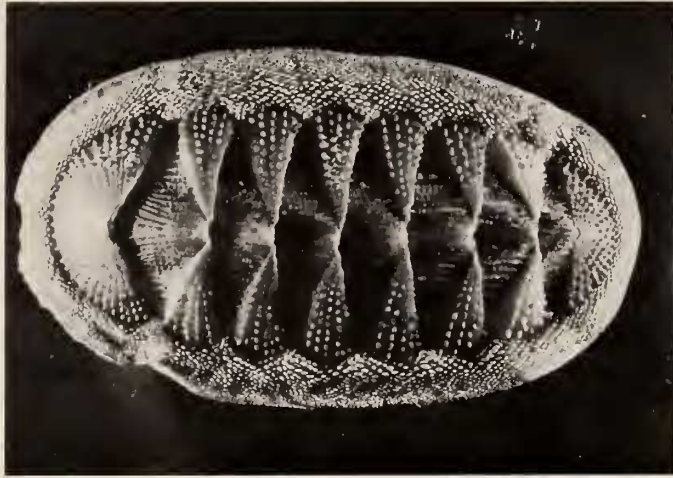


Figure 1



Figure 2

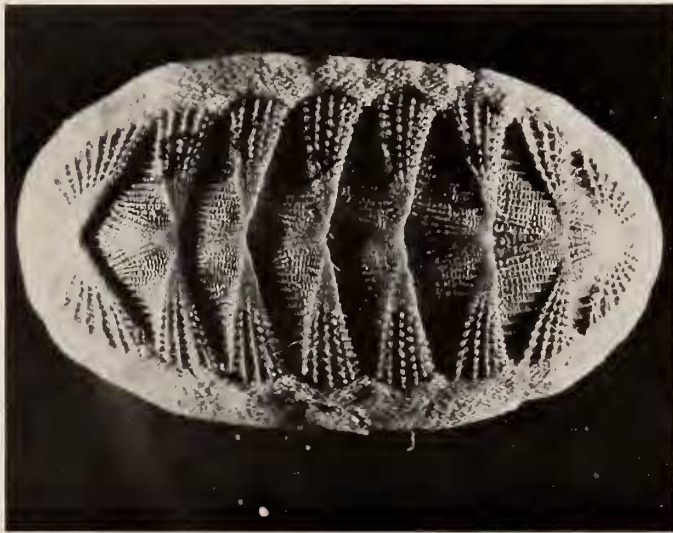


Figure 3

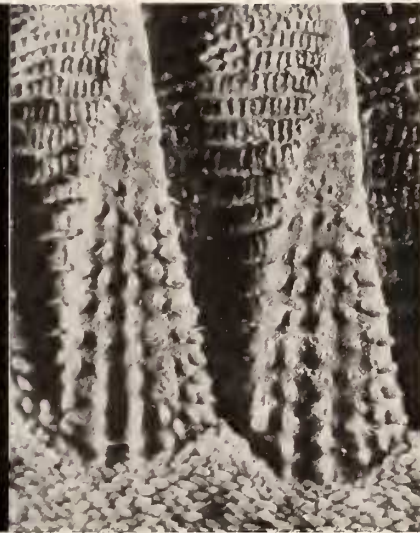


Figure 4

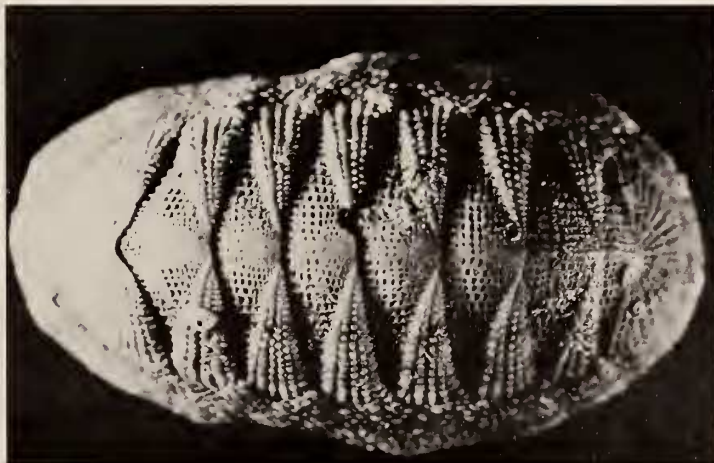


Figure 5

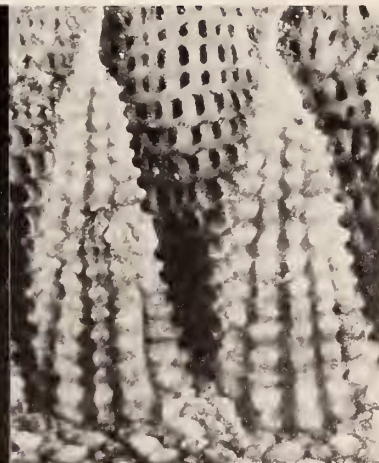


Figure 6



*tertia pars totius animalis longitudinis ad vicinitatem ani usque porrecta. Lamellarum branchialium numerus circiter 36. Adulti longitudo 0,23 Decim. Patria: California.*" (MIDDENDORFF, 1847a: 118).

**Description:** Neotype (Figures 1, 2) is oval in outline. Shell and girdle are a rather uniform reddish brown with some darker diffused blotches in the pleural areas; 2 wide bands of a creamy-white color cut across the specimen, transversally, at the level of valves ii and vii. The specimen, preserved in ethyl alcohol is perfectly flat; it measures 33.0 mm in length (including girdle), 19.2 mm in width (at the iv level), and 5.2 mm in height. Width/length ratio: 0.58. Jugal angle about  $101^\circ$ .

The tegmentum general surface is minutely granulose. The anterior valve displays some 29 radial rows of very well defined tubercles. The tubercles are round and measure about  $250\ \mu\text{m}$  in diameter and height; they are clearly separated from each other by a distance at least as large as their diameter. There are about 7-9 tubercles per radial row; the tubercles towards the top of the valve have fallen off, but their still visible scars indicate that there might have been about 10-11 such tubercles per radial row. On the valve there are no ribs as such; the rows of tubercles define by their presence "ribs" that are only virtual. Otherwise, the surface of the valve is smooth, almost glossy, flat and undivided by sulci or undulations. The intermediate valves, ii to vii, show well defined lateral areas bearing 4-5 similar rows of tubercles disposed in a radial fashion. The central areas display some 14-15, well carved, longitudinal riblets to a side, riblets which tend to diverge forward moderately; between the riblets there is coarse but definite latticing, which becomes obsolete or totally absent towards the jugum. The jugal tract riblets tend to diverge forward, most particularly on valve ii where they outline a wedge-like figure. Posterior valve sculptured in conformity with the other valves. The mucro is central, well defined, but not prominent; the post mucro area is relatively flat except for the presence of about 20 radial rows of tubercles.

The girdle is about 2.5 mm wide, covered with imbricating scales. The scales are strongly convex, and some show a prolongation, nipple, or mammilla, on the dorsal edge [an observation already made by MIDDENDORFF (1847b, plt. fig. 2d), and LELOUP (1940, fig. 30)]. The scales attain sizes of  $450\ \mu\text{m}$  in length. The surface of most scales appears to be smooth or minutely granulose; some occasional scales show very faint, almost obsolete striations.

The articulamentum is white. Sutural laminae are sharp, semioval, relatively short. Sinus is moderately shallow; sinus laminae show a few, irregular pectinations, and are often neatly demarcated from the adjacent sutural

laminae by a small notch. Eaves are solid. Insertion teeth are clean cut, sharp, and relatively short. Slit formula 11-1-11.

The radula measures 13.0 mm in length. Radula relative length (length of radula/length of specimen) is 39%. Number of rows of teeth, 33. The median plate is very wide anteriorly ( $400\ \mu\text{m}$ ) where it displays a thin blade recurved ventrally; medially, the plate narrows rapidly to  $100\ \mu\text{m}$  in diameter; posteriorly, it enlarges again into a bulge that resembles two half-joined spheres (Figure 34).

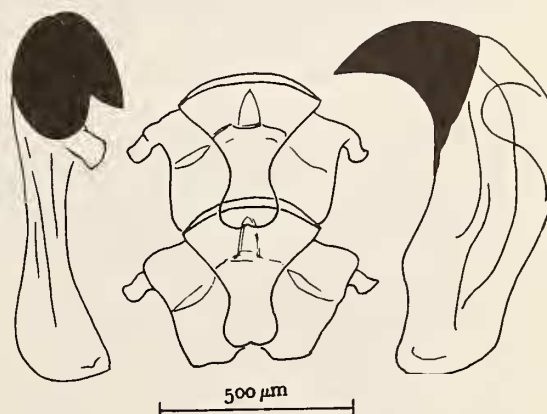


Figure 34

Radula (median, intermediate, and uncinated plates) of the Neotype of *Lepidozonia mertensii* (Middendorff, 1847) (camera lucida)

The intermediate plate (first lateral) has a robust recurved knobby growth at each outer-anterior corner. The uncinated (second lateral, major lateral) plate has a unicuspid blade, about  $400\ \mu\text{m}$  long. On the inner face of the shaft, immediately underneath the blade, there is a rather thick and long ( $200\ \mu\text{m} \times 100\ \mu\text{m}$ ) tubercle pointing inwardly. This tubercle is obviously very fragile for its presence cannot be demonstrated in but a few teeth; but the fact that it is a normal feature of the *Lepidozonia mertensii* radula has been verified many times in other specimens of the same species obtained at the same and other collecting sites.

Scanning electronic micrographs (SEM) of the girdle scales were obtained through the courtesy of Hans Bertsch, Donner Research Laboratory, University of California, Berkeley (Figures 20, 21) from another specimen: The hypotype, dry and flat, measures 26.4 mm in length; it was collected by A. J. Ferreira, on August 4, 1973, at Lovers' Point, Monterey Bay ( $36^\circ 37' \text{N}$ ,  $121^\circ 55' \text{W}$ ), Monterey County, California, in 5 m of water (AJF 56).

**Individual Variation:** In color, *Lepidozona mertensii* varies appreciably although remaining within the red-orange hues. Within the basic coloration, there are often markings in the form of triangular blotches at the jugum, or dark brown suffusions along the pleural areas, or a peppering of lighter (or darker) specks throughout the tegmentum. Rather characteristic of the species is the presence of one or two transversal bands of a lighter color, creamy-orange to white. When present, the posterior transversal band covers most of the vii valve and adjacent girdle, while the anterior transversal band covers the ii valve and adjacent girdle. Among 83 specimens (7 lots) from Monterey Bay, California, 9 specimens had a single band (on vii), and 11 had a double band. Seemingly the posterior band is much more common than the anterior band for I have never seen a specimen with anterior band without a posterior one. Color does not seem to be correlated to geographic location, depth, or any other recognizable aspect of the habitat.

Individual variation in meristic characteristics is summarized in Table 1, based on a random sample of 20 adult specimens from Monterey Bay, California.

As to size, specimens measuring up to 45 mm in length were found in several lots. Unusually large specimens were collected at Victoria, Vancouver Island, Canada, the largest measuring 51.9 mm in length, 30.8 mm in width, and 10.7 mm in height (Crittenden Colln., leg. S. Crittenden intertidally, June 1970). Specimens above 7 - 8 mm in length were found to display all of the identifying characteristics of the species. The smallest specimens examined, 4 - 5 mm long, already showed the typically convex girdle scales, often faintly striated, but with no mammillation; in contrast with larger ones, these small specimens usually display a spiculose fringe.

**Distribution:** *Lepidozona mertensii* seems to have a continuous distribution between the parallels 30° N and 58° N, between upper Baja California and Alaska. The northernmost finding in the examined collections is Auke Bay (58° 21' N; 134° 41' W), 24 km NW of Juneau, Alaska (CASIZ, leg. J. E. Bailey, 1 adult specimen, at 25 m). The southernmost finding is Sacramento Reef, just S of Isla San Geronimo (29° 43' N, 115° 45' W), Baja California,

Mexico, 1 specimen at 6 - 12 m (LACM 71-91, leg. J. H. McLean, Sept. 26 - 27, 1971). Two specimens were found at Kellet Channel, south of Cedros Id. (27° 57' N, 115° 08' W), Baja California, Mexico (LACM 71-159, leg. J. H. McLean & P. LaFollette, *R/V Searcher*, Oct. 20, 1971), sizes 18 and 9 mm in length, and another specimen, 7 mm long, found at the southern tip of Natividad Island (27° 52' N, 115° 11' W), Baja California, Mexico, (LACM 72-116, leg. J. H. McLean, Sept. 25, 1972); but they were referred to *L. mertensii* only tentatively, their small size, and a few ambiguous features precluding a positive identification.

Between these two extreme points, *Lepidozona mertensii* was found often abundantly in many other collecting stations, including the offshore islands of San Geronimo (LACM 71-91), San Nicolas (LACM 72-100), Catalina (LACM 65-6), Santa Cruz (LACM 63-5), San Miguel (LACM 67-38), Farallon (LACM 62-9), San Juan (CASIZ-AGS 10097; CASG 18058; LACM 66-39), Vancouver (LACM 63-31, 63-32, 73-35, 73-38, 73-39, 73-40), Queen Charlotte (LACM 69-52), Baranof (CASG 43941; LACM 73-13, 73-15, 73-16), Kosciusko (CASIZ 32430), Dall (CASG 32433, 32564), Forrester (SDNH 23436; UCLA 22317).

The recorded depth range of *Lepidozona mertensii* extends from the intertidal zone to about 100 m (CASG 32536, 36334 off San Pedro; CASG 24147, Monterey Bay, California).

*Lepidozona mertensii* has been reported in northern Japan, at Hakodate and Mutsu Bay (Is. TAKI, 1938: 390-393; 1962: 41).

**Remarks:** The presence of *Lepidozona mertensii* at Guadalupe Island, Mexico, as reported by CHACE (1958) and A. G. SMITH (1963), must be considered as misidentifications for the rather similar *Lepidozona guadalupensis* Ferreira (herein), as concluded from the examination of the material collected at Guadalupe Island by M. Woodbridge Williams, in July 1946 (CASIZ G-32746), by C. L. Hubbs *et al.* (SDNH 9957), and recently by Welton L. Lee & A. J. Ferreira (AJF 210-211). To my knowledge, *Lepidozona mertensii* has not been collected at Guadalupe Island.

### Explanation of Figures 7 to 12

Figure 7: *Lepidozona scabricostata*. 14.5 mm long, Cordell Banks, California (CASG 43983)

Figure 8: *Lepidozona scabricostata*. Close-up of specimen in Figure 7 to show detail of lateral areas

Figure 9: *Lepidozona willetti*. Paratype (CASG 1123)

Figure 10: *Lepidozona willetti*. Close-up of specimen in Figure 9 to show detail of lateral areas

Figure 11: *Lepidozona retiporosa*. Topotype, 13.0 mm long (CASG 43840)

Figure 12: *Lepidozona retiporosa*. Close-up of specimen in Figure 11 to show detail of lateral areas



Figure 7



Figure 8

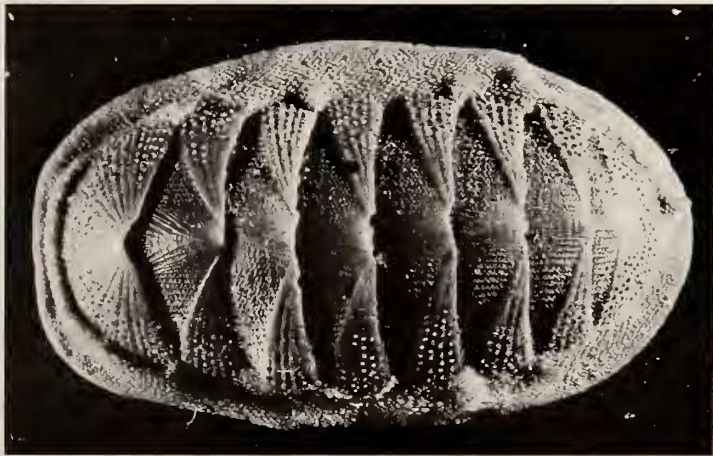


Figure 9



Figure 10

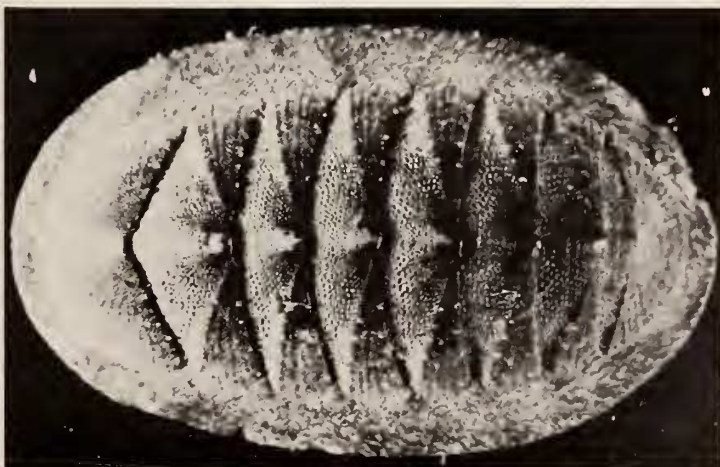


Figure 11

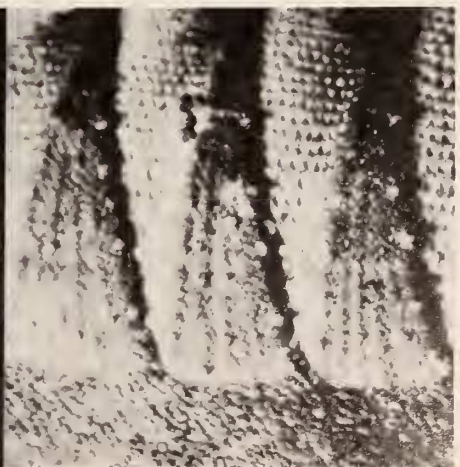


Figure 12





*Lepidozона cooperi* (Dall, 1879)

(Figures 3, 4, 22, 23)

*Ischnochiton cooperi* DALL, 1879, 1: 296, fig. 15 (radula); WOOD & RAYMOND, 1891, 5: 58; PILSBRY, 1892, 14: 127, plt. 26, figs. 27-30 (in section *Lepidozона*); 1898, 50: 288; HEATH, 1904, 56: 257; 1905, 29 (12): 391-392; BERRY, 1907, 21 (5): 51; PACKARD, 1918, 14 (2): 293-294; CHACE & CHACE, 1919, 2 (6): 3 (fossil); 1933, 46 (4): 124; DALL, 1921, 112: 192 (in section *Lepidozона*); OLDROYD, 1927, 2 (3): 281 (in section *Lepidozона*); JOHNSON & SNOOK, 1927: 564, fig. 670; SIMROTH & HOFFMANN, 1929: 314; STOHLER, 1930, 91 (5/8): 151, 155; LELOUP, 1940: 12-15, figs. 34-37; RICKETTS & CALVIN, 1962: 89, 453, plt. 19, fig. 4

*Ischnoplax cooperi*, THIELE, 1893, 2: 376, plt. 31, fig. 2 (radula)

*Ischnochiton (Lepidozона) cooperi*, BERRY, 1922, 11: 473, plt. 11, figs. 1-12 (fossil); A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948, 26: 207; PALMER, 1958: 273-274, plt. 34, figs. 1-6

*Lepidozона cooperi*, BURGHARDT & BURGHARDT, 1969a, 12 (2): 228; 1969b, 21, plt. 2, fig. 27 (in color); RICE, 1971: 20, plt. 4, fig. 10 (in color); ABBOTT, 1974: 395, fig. 4641; A. G. SMITH in LIGHT'S, 3rd ed., 1974: 463, 465, plt. 109, fig. 5

*Ischnochiton cooperi acutior* Carpenter in DALL, 1919, 55 (2283): 508; DALL, 1921, 112: 192 (in section *Lepidozона*); OLDROYD, 1927, 2 (3): 282; WILLETT, 1935, 49 (2): 44; PALMER, 1945, 58 (3): 101; 1958: 274, plt. 34, fig. 16 (synonymized with *I. cooperi*); A. G. SMITH, 1977, 19 (3): 222-223 (synonymized with *Lepidozона cooperi*)

**Nomenclatural Comments:** The name *Ischnochiton cooperi* was first published by DALL (1879) who attributed it to Carpenter whose unpublished manuscript he had been "authorized to use" (DALL, *l.c.*: 282). Dall limited himself to describe and figure the radula; but from all appearances the description was his own, not Carpenter's, as revealed through the examination of the pertinent pages in Carpenter's manuscript made available to me through the courtesy of Dr. Joseph Rosewater, National Museum of Natural History, Washington, D.C. Manuscript names having no standing in taxonomy, Dall's published account, an "indication" in the sense of Articles 16, 17 and 24.b of the International Code of Zoological Nomenclature (ICZN), clearly establishes the authorship of the species as Dall's.

The synonymy of *Ischnochiton cooperi acutior* Carpenter in Dall, 1919, was suggested by Dall himself with the comment that "the only differences from *I. cooperi* I could perceive were that the specimens of the variety *acutior* were lighter in color, more emphatic in sculpture . . . In a group where color is often without systematic value, these differences seem hardly worthy a name . . ." (DALL, 1919: 508). From the examination of the holotype (USNM

30734), A. G. SMITH (1977: 223) concluded "that *Lepidozона cooperi acutior* merely represents a young phase of *L. cooperi* . . ."; the study of A. G. Smith's color slide of the holotype (CASIZ, Color Slide Series No. 2048) led me to the same conclusion. The synonymy of *acutior* had also been suggested by PALMER (1958: 274) upon the examination of specimens labelled "types" in the Carpenter Collection at the Redpath Museum, Montreal, Canada. However, a curious fact must be noted here: Although the 5 specimen-lot from Todos Santos Bay (Redpath Museum no. 18) figured in PALMER (1958: plt. 34, figs. 1-5) are unquestionably *Lepidozона cooperi*, the lot of 6 specimens from "near S. Diego" (Redpath Museum no. 8) is not correctly identified. Despite being accompanied by a characteristic Carpenter label of white ink on glass which reads "*Ischnochiton cooperi*, var. *acutior*," and having been regarded and photographed as such by PALMER (1958: plt. 34, fig. 6), all 6 specimens in the Redpath Museum no. 8, examined on a loan through the courtesy of Dr. Vincent Condé, Redpath Museum, are of *Lepidozона sinudentata* (Carpenter in Pilsbry, 1892).

**Diagnosis:** Chitons of medium size (up to 4 cm), uniform color of greenish, gray, or brown tones. End valves and lateral areas with rows of strong tubercles on radial ribs separated by well defined sulci. Central areas with longitudinal riblets, cross-ribbed. Articulation blue. Girdle scales convex, oval, with deep striations.

**Type Material:** "No specimens have been found which could be identified as type for Dall's description" (PALMER, 1958: 273). Since further search for Dall's original material proved fruitless, a neotype specimen is here designated and illustrated in accordance with Article 75 of ICZN (London, 1964). The specimen chosen as neotype is part of a lot of 8 specimens collected by myself (AJF 149) at Cayucos (35°27'N, 120°54'W), San Luis Obispo County, California, intertidally, on April 11, 1974. The neotype (partly disarticulated) and its radula are in repository at the California Academy of Sciences, Department of Geology (CASIZ, Type Series No. 702). Specimens from the neotype-lot are deposited at the Los Angeles County Museum of Natural History (LACM 1858), National Museum of Natural History (USNM 770961), and Academy of Natural Sciences of Philadelphia (ANSP 344915).

The holotype of *Ischnochiton cooperi acutior* is at the National Museum of Natural History (USNM 30734).

**Type Locality:** Cayucos (35°27'N, 120°54'W) San Luis Obispo County, California. The locality of Dall's specimen is unknown (PALMER, 1958: 273).

**Description:** DALL (1879: 266; fig. 15) only described and figured the radula. The earliest full description of the species comes from PILSBRY (1892, 14: 127; figs. 27 - 30) whose material [ANSP 118659] has been regarded as "typical" by some authors.

The neotype is oval and somewhat carinated. The color is a uniform dingy gray. Dried, but fully extended, it measures 36.8 mm in length, 21.5 mm in width, and 7.0 mm in height. Width to length ratio: 0.58. Jugal angle about 96°.

The anterior valve displays about 20 poorly differentiated radial ribs which show a tendency to twin towards the periphery. The ribs are crested by well formed tubercles, oblong rather than round, which show a tendency to become confluent. On average the tubercles measure 0.3 mm in diameter; there are about 15 tubercles on each rib. The posterior valve shows, in the post mucro area, a similar sculpture of some 20 radial ribs crowned by a row of tubercles; the mucro is central, well defined but not conspicuous. The lateral areas of the intermediate valves bear 4 - 6 tuberculated ribs, also with a tendency to bifurcate towards the periphery. The central areas have about 18 - 20 longitudinal riblets per side, neatly cross-ribbed for a definite lattice effect. The jugal tract has only vestigial cross-ribbing; it has a tendency to diverge forward, particularly on valve ii where the riblets outline a wedge-like figure.

The articulamentum is light blue in color. Sutural laminae are sharp, semioval, and separated by a relatively shallow sinus. Sinus laminae are irregularly pectinated, and separated from the adjacent sutural laminae by a small notch. Eaves are solid. Teeth are sharp-edged, clean-cut, and straight. Slit formula 10 - 1 - 11.

The girdle is about 2.5 mm wide, covered with imbricating oval scales. The scales are moderately convex, and display some well marked undulations, 8 - 10 per scale, which define that many ribs and striations. The largest scales average 360 µm in length.

The radula measures 13.2 mm in length, and has 34 rows of mature teeth. The relative length of the radula is 36%. The median plate is wide anteriorly (330 µm), then narrows rapidly in its middle part (100 µm) to bulge again posteriorly in a sort of spheroid; from its anterior edge, a thin blade curves ventrally. The intermediate plate has a strong, knobby growth in the outer-anterior corner. The uncinated plate has a long (450 µm) unicuspid blade on a shaft about 700 µm long. A thick and long tubercle in the upper part of the uncinated plate points inwardly.

The specimen in the photograph (Figure 3, 4), measures dried, but fully extended, 28.2 mm in length, 17.3 mm in width, and 6.8 mm in height. It is part of a lot of 5 specimens collected at Bolinas, Marin County, California (CASG 30915).

The specimen used for the SEM micrographs of the girdle scales (Figures 22, 23), measures 30 mm in length, and was collected at Point St. George, Del Norte County, California (CASG 53072).

**Individual Variation:** *Lepidozона cooperi* varies little in color, staying within the range of dark browns, greens, or grays, for an overall dingy, inconspicuous appearance. Variation in meristic characteristics are summarized in Table 1. In size, only a few specimens examined were longer than 40 mm. The largest specimen seen measures 44.5 mm (SDNH 53812, Crescent City, California). Specimens as small as 5 mm already show identifying characteristics, particularly the distinctive girdle scales.

**Distribution:** The known range of *Lepidozона cooperi* extends from latitude 32° N to 48° N. The northernmost record is Neah Bay (48° 22' N; 124° 37' W), at the entrance of the Strait of Juan de Fuca, Washington (RICE, 1971). The southernmost locality is Puerto Santo Tomas (31° 34' N; 116° 40' W), Baja California, Mexico (LACM 67-2, leg. J. H. McLean, Jan. 8 - 10, 1967). The species has been recorded, too, from Catalina (DALL, 1921), and Sta. Cruz Islands (AJF, Dec. 1970) on the outer coast of California.

### Explanation of Figures 13 to 19

Figure 13: *Lepidozона guadalupensis* Ferreira, spec. nov. Paratype 13.0 mm long (LACM 1857)

Figure 14: *Lepidozона guadalupensis* Ferreira, spec. nov. Close-up of specimen in Figure 13 to show detail of lateral areas

Figure 15: *Lepidozона sinudentata*. Topotype, 15.0 mm long, Monterey Bay, California (AJF 89)

Figure 16: *Lepidozона sinudentata*. Close-up of specimen in Figure 15 to show detail of lateral areas

Figure 17: *Lepidozона sinudentata*. 17.5 mm long specimen from Todos Santos Bay, Baja California, Mexico, ex G. Willett collection (UCLA 22382). Close-up of lateral areas

Figure 18: *Lepidozона sinudentata*. 11 mm long specimen from San Diego, California (CASG 40837). Close-up of lateral areas

Figure 19: *Lepidozона sinudentata*. 12 mm long specimen from Carmel Bay, California (CASG 53074): scales on the underside of the girdle approximately × 300

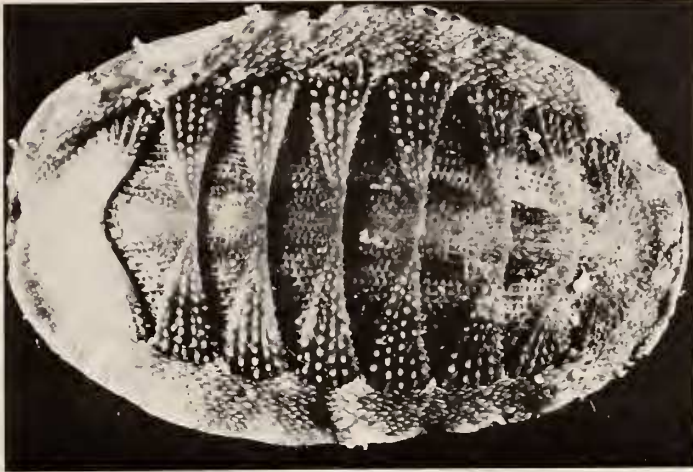


Figure 13



Figure 14

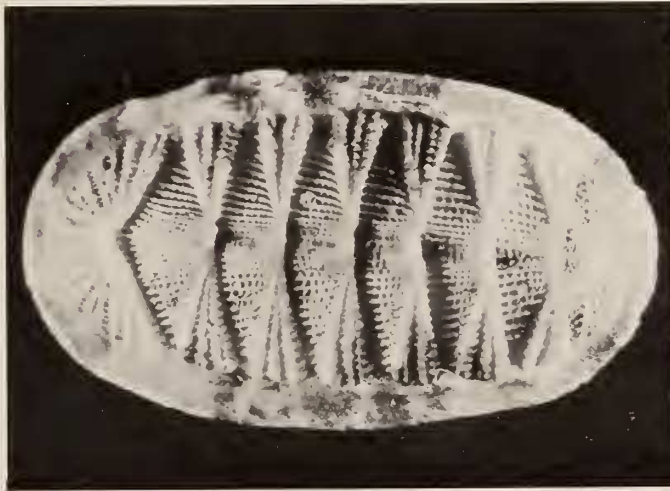


Figure 15



Figure 16



Figure 17

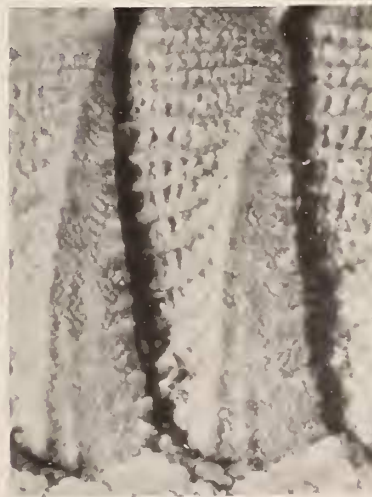


Figure 18



Figure 19



The known depth range is from intertidal to about 20 meters.

**Remarks:** In size, shape, and valve sculpture, *Lepidozonia cooperi* is rather close to *L. mertensii*. The main distinguishing features are in the tuberculated radial ribs, the color of the articulamentum, and the very decidedly different girdle scales. To a considerable extent, the two species share range and habitat, although *L. cooperi* seems to favor shallower depths than *L. mertensii*. In general appearance, size, and coloration, *L. cooperi* is remarkably similar to *Lepidozonia coreanica* (Reeve, 1847) from Japan; the two species may be regarded as cognates, the differences in sculpture being rather subtle and difficult to pinpoint except for the distinctive, though similar, girdle scales.

*Lepidozonia pectinulata* (Carpenter in Pilsbry, 1893)

(Figures 5, 6, 28)

- Ischnochiton (Lepidopleurus) pectinatus* CARPENTER, 1864a: 612 (Reprinted, 1872: 98), *nomen nudum* [not *Chiton pectinatus* Sowerby, 1840]; 1866, ser. 1, 3: 211 - 212
- Lepidopleurus pectinatus* CARPENTER, 1864b: 649 (Reprinted, 1872: 135) [= *Ischnochiton cooperi* Carpenter in Dall, 1879, in part, *vide* PILSBRY, 1893, 14: 129] - COOPER, 1867: 22; 1870: 59
- Ischnoplax pectinatus*, KEEP, 1887: 112 (Reprinted, 1888, 1891, & 1893)
- "*Chiton (Lepidopleurus ?) pectinulatus* Cpr.", DALL in ORCUTT, 1885: 544, *nomen nudum*
- Lepidopleurus pectinulatus* Carpenter in MS, PILSBRY, 1893, 14: 129 [syn. of *Ischnochiton clathratus* (Reeve, 1847) in part]
- Ischnochiton pectinulatus*, BERRY, 1922: 412, 414, 421, tbl. 1 (fossil)
- Ischnochiton (Lepidozonia) pectinulatus*, BERRY, 1922: 471 - 472, plt. 10, figs. 4 - 6
- "*Ischnochiton punctulatissimus* Carpenter", LOWE, 1904: 19 [? error for *I. pectinulatus*]
- Ischnochiton clathratus* (Reeve, 1847), PILSBRY, 1892 - 1893, 14: 128 - 129 (in part); KEEP, 1904: 349; BERRY, 1907: 51; CHACE, 1917: 30 (fossil) [= *I. (Lepidozonia) sanctaemonicae* BEITY, 1922, *vide* BERRY, 1922: 471, footnote]; OLDROYD, 1924: 193; 1927: 282; LELOUP, 1940: 3, 15 - 18; figs. 38 - 41
- Ischnochiton (Ischnochiton) clathratus* (Reeve, 1847), DALL, 1921: 192 (in section *Lepidozonia*)
- Lepidozonia pectinulata*, FERREIRA, 1974: 165; A. G. SMITH, 1977: 216, 229 - 231
- Ischnochiton bryanti* DALL, 1919: 503; 1921: 190; A. G. SMITH, 1947: 18; BURGHARDT & BURGHARDT, 1969: 16 (syn. of *I. brunneus* Dall, 1919); ABBOTT, 1974: 395
- Ischnochiton brunneus* DALL, 1919: 504; 1921: 190; OLDROYD, 1927: 271; A. G. SMITH, 1947: 18; BURGHARDT & BURGHARDT, 1969: 16 (with syn. *I. bryanti* Dall, 1919); ABBOTT, 1974: 395

*Ischnochiton (Lepidozonia) californiensis* BERRY, 1931: 255 - 258, pls. 29, figs. 1 - 2; A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948, (4) 26 (8): 207; PALMER, 1958: 272 - 273; plt. 31, figs. 5, 6

*Ischnochiton californiensis*, THORPE, 1962: 205

*Lepidozonia californiensis*, A. G. SMITH, 1960: 56; fig. 38, 8 (fossil); MCLEAN, 1969: 64; fig. 35.5; BURGHARDT & BURGHARDT, 1969: 20, 43, plt. 2, fig. 26 (in color); PHILLIPS, 1971: 22; ABBOTT, 1974: 395

**Nomenclatural Comments:** CARPENTER (1864b: 612) introduced *Ischnochiton (Lepidopleurus) pectinatus* without a description. The *nomen nudum* situation was soon remedied when Carpenter provided a short description of the species (1864b: 649), and a full description later (1866, 3: 211 - 212). According to PILSBRY (1893, 14: 129), Carpenter's first description of *Lepidopleurus pectinatus* [so inadequate that it is impossible to say to what taxon it would apply] referred to "*I. cooperi*, Cpr."; and the second, much fuller description of the species (1866) "seems to have included both this species [*Ischnochiton clathratus* (Reeve, 1847), *sensu* PILSBRY, 1893] and *I. cooperi*." However, afterwards, "upon receipt of better material," Carpenter distinguished *I. cooperi* from *I. pectinatus*, and [in the realization that the name "*pectinatus*" was preoccupied by *Chiton pectinatus* Sowerby, 1840] re-named the latter *pectinulatus*.

Nomenclatural difficulties might have been minimal at this point were it not for Pilsbry's misunderstanding of *Chiton clathratus* Reeve, 1847, as the "species that seems to replace *I. mertensii* south of Monterey . . . a dingy, lusterless shell resembling *mertensii* in the shape of the girdle scales . . ." (PILSBRY, 1893: 129), and, as such, senior synonym of *I. pectinulatus* Carpenter in MS.

The misunderstanding so created was not unraveled until BERRY (1931) pointed out that Pilsbry's interpretation of *Chiton clathratus* Reeve, included two distinct species, *Lepidozonia clathrata* (Reeve, 1847) confined to the Gulf of California, Mexico, and "the commonest southern California *Lepidozonia*" to which old collectors [like Henry Hemphill (A. G. SMITH, 1977: 230)], and authors [like BERRY himself (1922)] had referred to as "*pectinulatus*."

However, BERRY (1931) reached the conclusion that Carpenter's "*pectinulatus*" was not a valid name for the southern California species since it had been first published (PILSBRY, 1893) in synonymy, a fact which, by the old *Règles* (1905) [in a rule not changed until the ICZN of 1963], made it unavailable for purposes of nomenclature. In this frame of opinion, Berry concluded that the southern California species had been left without a valid name, and proceeded to rename it *Ischnochiton (Lepidozonia) californiensis* Berry, 1931.

It now seems that Berry's new name for the species was unnecessary for the following reason: 1) Carpenter's second description (1866) of *Ischnochiton* (*Lepidopleurus*) *pectinatus* is quite adequate and explicit even by present standards, 2) the existence of a syntype series (Redpath Museum no. 70) of *I. pectinatus* labeled by Carpenter as "type" (photographed in PALMER, 1958: pl. 31, figs. 5, 6) [not mentioned in either PILSBRY, 1893, or BERRY, 1931], and 3) the fact that the name "*pectinulatus*" was clearly validated by PILSBRY (1893: 129) as replacement for "*pectinatus*." Meanwhile, Berry's objections to the use of the name "*pectinulatus*" were further weakened in 1963 when the ICZN modified the rule 11(d) to allow the use of such names in synonymy if, before 1961, they had been treated as available names. It is ironical to observe that BERRY (1922) himself clearly used *L. pectinulata* as an available name, thus unwittingly providing the basis for invalidating his new name "*californiensis*."

In this respect, some unpublished notes left by Pilsbry [conveyed to Allyn G. Smith (personal communication) through R. Tucker Abbott, then with the Academy of Natural Sciences of Philadelphia] and clearly intended for publication, are of historical interest. With the kind permission of Dr. Robert Robertson (*in litt.*, 22 October, 1973), I quote from Pilsbry's notes on the subject of "*Lepidopleurus* *pectinulatus* Cpr. MS": "... Carpenter had formerly called the southern California shell '*L. pectinatus*' (not of Sowerby) though this is known by specimens he labeled rather than by his inadequate definition. I stated (p. 129) [Manual of Conchology, 1893, vol. 14] that he had 'renamed the present form *pectinulatus*'. The 'present form' referred to being that I had just described [*C. clathratus* Reeve]. My description and figures were from Californian specimens . . . My definition did not 'include both Panamic and Californian races' as stated by Dr. Berry . . . I, as it now appears erroneously, considered Reeve's unlocalized *C. clathratus* to be the Californian species . . . The Californian species was already commonly known under the name *pectinulatus* when I wrote the monograph . . . There seems to be no necessity for giving a new name in view of the treatment of the form in the Manual of Conchology. It should stand as *Ischnochiton* (*Lepidozona*) *pectinulata* ("Cpr.") Pils. . . with the synonymy as given by Berry (1931: 255) to which is to be

added *I. (L.) californiensis* Berry, l.c. . . a name which appears to me to be superfluous." Pilsbry's belated conclusions are supported by the finding of two lots of specimens in the Type Collection of the Academy of Natural Sciences of Philadelphia associated with the name *pectinulatus*. One (ANSP 118664) consists of 13 specimens accompanied by three labels which, combined, read: "*Lepidopleurus pectinulatus* Cpr.; San Diego, California; collected by Henry Hemphill; on rocks between tides; Type, figs. 31 - 33" [the statement "Type, figs. 31 - 33" obviously refers to Pilsbry's monograph in Tryon's Manual of Conchology, 1892 - 1893, vol. 14; and together with the identification *I. pectinulatus* Cpr., it is lettered in ink, likely by Pilsbry himself (SMITH, 1977: 230)]. The second lot (ANSP 118662), consists of two specimens; the label reads "*L. pectinatus* Cpr./*I. clathratus* Rv. . . ." the name "*clathratus*" had been crossed out, and the name "*californiensis*" written in pencil over the name "*pectinatus*"; to the right of the card on which the larger specimen seems to have been mounted, a pen-written "2nd measurement/M.C. p. 128" suggests that the specimen was used for one of the measurements published in the Manual of Conchology (SMITH, 1977: 229). The specimens in both lots, available through the generosity of Dr. Robert Robertson, Academy of Natural Sciences of Philadelphia, are unquestionably conspecific with *Ischnochiton* (*Lepidozona*) *californiensis* Berry, 1931, and with Carpenter's syntype series of *I. pectinatus* at the Redpath Museum.

It is interesting to note that prior to Pilsbry's monograph, the name "*pectinulatus* Cpr." had already been introduced in the literature, albeit as a *nomen nudum*, by DALL (*in* ORCUTT, 1885) who had been working from Carpenter's MS, presumably the same MS used by Pilsbry.

From the marshalling of all the evidence, it seems appropriate to call the species in question *Lepidozona pectinulata* (Carpenter in Pilsbry, 1893), and so bring the whole taxonomic problem to rest.

The synonymization of *Ischnochiton brunneus* Dall, 1919, and *Ischnochiton bryanti* Dall, 1919, is based upon Dall's original descriptions, and the examination of the respective holotypes made available through the kindness of Dr. Joseph Rosewater, United States Museum of Natural History, Washington, D.C.

### Explanation of Figures 20 to 27

Figure 20: *Lepidozona mertensii*. Girdle scales. approx.  $\times 240$   
 Figure 21: *Lepidozona mertensii*. Girdle scales. approx.  $\times 100$   
 Figure 22: *Lepidozona cooperi*. Girdle scales. approx.  $\times 300$   
 Figure 23: *Lepidozona cooperi*. Girdle scales. approx.  $\times 100$

Figure 24: *Lepidozona scabricostata*. Girdle scales. approx.  $\times 300$   
 Figure 25: *Lepidozona scabricostata*. Girdle scales. approx.  $\times 60$   
 Figure 26: *Lepidozona retiporosa*. Girdle scales. approx.  $\times 650$   
 Figure 27: *Lepidozona retiporosa*. Girdle scales. approx.  $\times 400$

SEM micrographs by Hans Bertsch



Figure 20



Figure 22



Figure 21



Figure 23



Figure 24

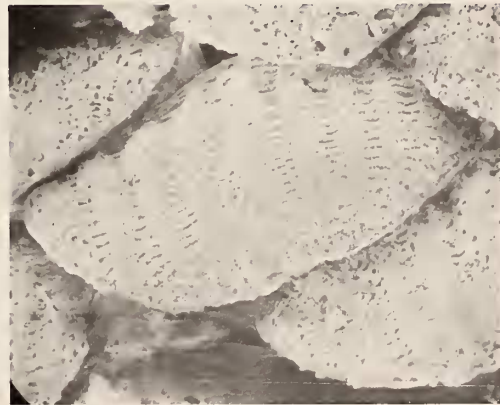


Figure 26



Figure 25



Figure 27





**Type Material:** "There are in the Redpath Museum two complete specimens and three separate plates which were labelled by Carpenter, 'Type La Paz Pease'" (PALMER, 1958: 273). Although the locality of the specimens must be in error, the specimens must be regarded as a syntype series. The one specimen figured in PALMER (1958: plt. 31, figs. 5, 6), whose dimensions are given as  $25 \times 10$  mm, is here designated as lectotype; the other two in the lot as paralectotypes (Redpath Museum No. 70).

*Ischnochiton (Lepidozona) californiensis* Berry, 1931: Holotype in Berry Colln. (Cat. No. 5226). Paratypes in Berry Colln. (Cat. No. 3119), SDNH, ANSP, USNM, British Museum (Natural History), and Stanford University (Department of Geology). Color slides of paratype (ANSP 161525) at CASIZ, Color Slide Series Nos. 2968 - 2969 (A. G. Smith).

*Ischnochiton brunneus* Dall, 1919: Holotype (USNM 58734a). Color slides at CASIZ, Nos. 2972 - 2973 (A. G. Smith), and Nos. 3107 - 3108 (AJF).

*Ischnochiton bryanti* Dall, 1919: Holotype (USNM 253826). Color slides at CASIZ, Nos. 2965 (A. G. Smith), and No. 3109 (AJF).

**Diagnosis:** Chitons of medium size (up to about 4 cm), uniformly colored mostly in tones of muddy brown to orange. End valves and lateral areas of intermediate valves with strongly granular radial ribs. Central areas with longitudinal riblets, clearly cross-ribbed. Girdle scales imbricated, strongly convex, faintly striated, and mammillated.

**Type Locality:** As mentioned above, the locality attributed to the syntypes must be in error. The first specimen reported as *I. pectinatus* Carpenter (1864a: 612), a *nomen nudum*, was from Catalina Island, California. The second reference (1864a: 649) mentioned specimens from Santa Barbara Islands. Carpenter's 1866 description lists Catalina and Santa Barbara Islands. The type locality is here restricted to Catalina Island, California.

**Original Descriptions:** "Olive, strong sculpture over shagreened surface: side areas ribbed; outer margin and inner sutures pectinated. Bch." (Carpenter, 1864a: 649).

"State Collection, No. 1073. L.t.'L. Mertensii' simili, sed omnino olivaceo; areis diagonalibus radiis plerumque iv. dense tuberculiferis, radioque altero suturali tuberculis inflexis, margines valvarum pectinantibus; costis transversis crebris validis; costulis longitudinalibus acutis distantibus superantibus, quarum margines suturas anticarum pectinant; valv. term. ut in areis diag. sculptis, seriebus tuberculorum creberrimis; tota superficie minutissime tuberculata: intus, valvis centralibus unifissatis, terminalibus xi-xv-fissatis: scalis pallii irregularibus, confertis, minutissime longitudinaliter striatis. Long. 0.85, lat. 0.50,

div.  $110^\circ$ . Variat: interdum aurantio nebulosa. Hab. Catalina Island, Santa Barbara Island, beach, Cooper." (Carpenter, 1866: 211 - 212).

**Description:** The splendid account of *Lepidozona californiensis* given by BERRY (1931) is amply sufficient for the understanding of *Lepidozona pectinulata*. The following observations are to be taken only as a supplement to, not an improvement upon that account.

The specimen studied (ANSP 118664, leg. H. Hemphill, San Diego, Calif.), is of a uniform dark muddy brown color (Figures 5, 6). Dried, but perfectly flat, it measures (including girdle) 27.0 mm in length, 16.3 mm in width, and 5.5 mm in height. Width/length ratio: 0.60. Jugal angle about  $99^\circ$ . Anterior valve shows about 24 radial ribs, some twinning towards the periphery. The ribs are composed of a series of granules (about 15 per rib), round, close-packed; each granule is separated from the ones above and below on the rib by a space about half as wide as the granules themselves. The space between the ribs is well defined, distinct, and about as wide as the granules. Posterior valve has some 20 similar granular radial ribs; mucro is low, and inconspicuous. Post-mucro area slightly concave. In the intermediate valves, the lateral areas have about 5 similar granular ribs; the granules in the posterior rib tend to be elongated in the antero-posterior direction, protruding posteriorly and so conferring on the posterior edge of the lateral area a serrated appearance. Central areas with longitudinal riblets (about 15 per side), with equally well developed cross-riblets which results in a marked clathrate appearance of square pits. The jugal riblets diverge forward on valve ii forming a wedge-like figure; similar, but less accentuated divergence of the jugal riblets is also seen on valve iii. The space between the longitudinal riblets at the jugum is smooth, not cross-ribbed. The girdle scales are large (up to 400  $\mu$ m), strongly convex, faintly striated. A nipple-like prolongation is observed at the dorsal edge of many of the scales, particularly on the larger ones closer to the valves; the nipple tends to be elongated along the edge, looking more like a crest than a nipple.

The soft parts of the animal had been removed. The articulamentum is bluish white. Sutural laminae are semi-oval, moderate in size. Sinus is relatively shallow; the sinusal laminae show a few irregular pectinations and, in some, there was a small notch separating them from the adjacent sutural laminae. Teeth, eaves, and slit formula not determined.

Color slides of the specimen at CASIZ Color Slide Series Nos. 3118 - 3119 (AJF).

Another specimen (CASG 43928, San Diego, shore, California, coll. T. S. Oldroyd, ex M. Gordon Colln.), was

used for SEM microphotographs of the girdle scales (Figure 28); the specimen measures 28 mm in length; it was the largest in a lot of 27.

A specimen from near the type locality (AJF 148, Bird Rock, La Jolla, San Diego County, California, leg. A. J. Ferreira, intertidally, April 10, 1974), measuring 25.0 mm in length (including girdle) was used for further examination: The eaves were solid, the slit formula was 11 - 1 - 12.

The radula of this specimen measures 11.2 mm in length, and it has 42 rows of teeth. Radula relative length, 48%. The median plate is wide anteriorly (280 µm) where it sports a small ventrally recurved blade; the plate narrows medially (to 100 µm) and ends posteriorly in a bulging spheroid, about 140 µm in diameter. The intermediate plate bears a knobby growth at the outer anterior corner. The uncinated plate is unicuspid, the blade being about 280 µm in length, on a shaft about 550 µm long. On the upper part of the shaft a thick, blunt tubercle protrudes inwardly, although only visible on a few plates.

**Individual Variation:** Color variations of *Lepidozона pectinulata* stay within rather narrow limits, from a uniform dark muddy brown to orange. Some occasional specimen shows a wide and ill-defined band of a lighter coloration of orange running longitudinally across the pleural and lateral areas. In size, *L. pectinulata* does not usually exceed 35 mm in length; the largest specimen examined measures 40 mm in length (CASG, San Diego, California, ex H. Hemphill Colln.). Variation in the number of radial ribs, slit formula, etc. is summarized in Table 1, based upon a random sample of 20 adult specimens.

**Distribution:** *Lepidozона pectinulata* seems to be confined to the San Diego Province, within the parallels 24° N and 35° N. The distribution seems to be continuous, and includes the offshore islands, with findings at Catalina Island (SDNH 57716; CASG 4055; LACM 64-26 & 71-99), San Clemente Island (SDNH 53814; LACM 66-51), San Geronimo Island (LACM 67-62), Sacramento Reef (AJF 94; LACM 71-91), San Martin Island (LACM 68-31), Natividad Island (LACM 72-116) and Cedros Island (SDNH 60709; LACM 67-65 & 71-92). Its northernmost record is Cayucos (35° 27' N, 120° 54' W) San Luis Obispo County, California (CASG 13784, H. Hemphill Colln.); the southernmost record is NW side of Santa Margarita Island (24° 31' N, 111° 57' W), Magdalena Bay, Baja California, Mexico (LACM 67-73, intertidal, leg. J. H. McLean, Dwyer Expedition, December 15, 1967). Bathymetrically, *L. pectinulata* has been collected from intertidal to about 20 m (LACM 72-115, 50 - 65 feet, S side Piedra Colorada, SW tip Cedros Island, Baja California, Mexico, leg. J. H. McLean, September 24, 1972).

**Remarks:** The relative allopatry between *Lepidozона pectinulata* and *L. mertensii* has been noticed since the days of PILSBRY (1893: 129). In relation to the species of *Lepidozона* in the Gulf of California it is worth pointing out that *L. pectinulata* has decided affinity not only to *L. clathratus* (Reeve, 1847) with which it was long confused, but to *L. formosa* Ferreira, 1974 as well.

*Lepidozона sinudentata* (Carpenter in Pilsbry, 1892)

(Figures 15, 16, 17, 18, 19, 29)

- Ischnochiton* (*Ischnochiton*) *sinudentatus* Carpenter MS in PILSBRY, 1892, 14: 128 (in section *Lepidozона*); DALL, 1921: 192 (in section *Lepidozона*); OLDROYD, 1927: 283 (in section *Lepidozона*); A. G. SMITH, 1977: 216, 235 - 236
- Ischnochiton* (*decipiens* var. ?) *sinudentatus*, PILSBRY, 1898: 288
- Ischnochiton sinudentatus*, KEEF, 1904: 349; BURCH, 1942: 7; PALMER, 1945: 101; LIGHT's Manual, 2nd ed., 1954: 217, 219
- Ischnochiton* (*Lepidozона*) *sinudentatus*, BERRY, 1922: 476 - 477, tbl. 1, plt. 12, figs. 10 - 17; PALMER, 1958: 276, plt. 30, figs. 8, 9; plt. 33, figs. 1 - 5; A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948: 208
- Ischnochiton clathratus* Reeve, 1847, var. *sinudentatus* Pilsbry, 1893 [= 1892], LELOUP, 1940: 3, 17 - 18
- Lepidozона sinudentata*, BURGHARDT & BURGHARDT, 1969: 22 - 23, 43 - 44; plt. 2, figs. 29 - 32 (in color) (with syn. *L. gallina* Berry, 1925); ABBOTT, 1974: 395 (with syn. *L. berryi* (Dall, 1919)); A. G. SMITH in LIGHT's Manual, 3rd ed., 1975: 463, 465
- Ischnochiton* (*decipiens* var. ?) *sinudentatus*, PILSBRY, 1898: 288
- Ischnochiton listrum* DALL, 1919: 504; OLDROYD, 1927: 271 - 272; BURGHARDT & BURGHARDT, 1969: 17; ABBOTT, 1974: 395; A. G. SMITH, 1977: 216, 227 (syn. of *L. sinudentata*)
- Ischnochiton* (*Ischnochiton*) *listrum*, DALL, 1921: 190
- Ischnochiton* (*Lepidozона*) *listrum*, A. G. SMITH, 1947: 18
- Ischnochiton berryi* Bartsch MS in BERRY, 1907: 51, *nomen nudum*
- Ischnochiton berryi* DALL, 1919: 507; 1921: 192; OLDROYD, 1927: 279; BURCH, 1942: 7; LIGHT's Manual, 2nd ed., 1954: 218; ABBOTT, 1974: 395 (? syn. of *Lepidozона sinudentata* (Carpenter in Pilsbry, 1892)); A. G. SMITH, 1977: 216, 220 (syn. of *L. sinudentata*)
- Ischnochiton* (*Lepidozона*) *berryi*, A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948: 207
- Lepidozона berryi*, BURGHARDT & BURGHARDT, 1969: 20, 44; plt. 2, fig. 32 (in color)
- Ischnochiton* (*Lepidozона*) *gallina* BERRY, 1925: 228 - 229; plt. 11, figs. 1, 2; A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948: 207, 208 [in error as *I. (L.) golischi* Berry, 1919]; A. G. SMITH, 1977: 216, 225 - 226 (syn. of *L. sinudentata*)

*Ischnochiton gallina*, WILLETT, 1935: 43-44 (syn. of *I. decipiens* Carpenter, 1892); ABBOTT, 1974: 395; fig. 4643 (syn. of *L. decipiens* (Carpenter in Pilsbry, 1892))

**Nomenclatural Comments:** By virtue of its high degree of intra-species variation, and its relatively wide bathymetric range, *Lepidozona sinudentata* has given rise to much confusion, and caused the description of several nominal species which have been found wanting in objective distinctions. The synonymization of *Lepidozona gallina* (Berry, 1925) imposed itself from the original description and accompanying photographs; it had been suggested already by WILLETT (1935) who considered *L. gallina* and *L. decipiens* conspecific, and by BURGHARDT & BURGHARDT (1969).

*Lepidozona berry* (Dall, 1919), and *L. listrum* (Dall, 1919) were conclusively resolved as synonyms of *L. sinudentata* from direct examination of their respective holotypes kindly loaned by Dr. Joseph Rosewater, United States Museum of Natural History, Washington, D.C.

The case of *Ischnochiton decipiens* Carpenter in Pilsbry, 1892, was more complex. On subjective grounds, the species has been equated with *Lepidozona sinudentata*. The examination of a series of 6 small chitons in the collection of the Philadelphia Academy of Sciences (ANSP 42122) with the label "*I. decipiens sinudentatus* Cpr./ Pacific Grove, nr. Monterey, Cal./H. Heath, Aug. 1," did not reveal any differences from other specimens of the very common (in the area) *L. sinudentata*; Pilsbry, in fact, had already referred Heath's specimens to *L. sinudentata* by citing them as "*Ischnochiton* (*decipiens* var.?) *sinudentatus* Cpr." (PILSBRY, 1898: 288). WILLETT (1935: 43-44) regarded *Ischnochiton decipiens* as a senior synonym of *I. (Lepidozona) gallina* Berry, 1925; and so did ABBOTT (1974: 395). BURGHARDT & BURGHARDT (1969: 21) cited *Lepidozona decipiens* with the added comment that "this species will probably turn out to be a synonym of *Lepidozona sinudentata*..." Recently, A. G. SMITH (1977: 223-224) concluded for the conspecificity of *Ischnochiton decipiens* and *I. berryi* Dall, 1919. Yet, on objective grounds, there is no way of knowing what the name *Ischnochiton decipiens* stood for. No type material was ever found (PALMER, 1958: 274), the species was never illustrated, and Carpenter's description as given by PILSBRY (1892: 123) is rather laconic and uninformative. Under the circumstances, it appears that *I. decipiens* should be considered a *nomen dubium* in as much as it can not be applied with certainty to any known taxon (ICZN, p. 151).

**Type Material:** The syntype series (Redpath Museum no. 27), available through the kindness of Dr. Vincent Condé, Redpath Museum, Montreal, Canada, carried the label [in white ink: ? Carpenter's own handwriting],

"*Ischnochiton sinudentatus* Cpr. (Type), California." The series consists of 4 specimens. The largest of these specimens, measuring 12.0 mm in length, is here designated as lectotype; it is partly disarticulated, with loose valves i, vii, and viii, permitting verification of the slit formula indicated by PILSBRY (1892: 128) as 10-1-9. The other 3 specimens in the series are here designated as paralectotypes; they measure 10.0 mm, 6.7 mm, and 4.9 mm in length. The types are figured in PALMER (1958), the here designated lectotype in plt. 33, figs. 1-5, and the largest of the paralectotypes in plt. 30, figs. 8, 9. Color slides of the syntype series, as well as of the designated lectotype are deposited at CASIZ, Color Slide Series No.s 2075-77 (A. G. Smith), and 3078-80 (AJF).

*Ischnochiton berryi* Dall, 1919: Holotype (USNM 193375), labelled "*Ischnochiton berryi*, Bartsch / (Fig'd type) / Pacific Grove." Color slides at CASIZ, Nos. 2960-61 (A. G. Smith) and 3094-95 (AJF).

*Ischnochiton listrum* Dall, 1919: Holotype (USNM 58,734). The label reads, "Type/ San Diego, Cal./ H. Hemphill." Color slides at CASIZ, Nos. 2562 (A. G. Smith), and 3117-18 (AJF).

*Ischnochiton (Lepidozona) gallina* Berry, 1925: Holotype, "A shell preserved dry S.S.B.757 entered as Cat. No. 4898 of the author's collection (ex-No. 1179, collection of R. H. Tremper)." Figured in BERRY (1925).

**Type Locality:** "California" as designated by Carpenter on the label attached to the type material. Following the suggestion implied in PILSBRY (1892: 128), the locality is here restricted to Monterey Bay (36°45'N, 121°55'W), Monterey County, California.

**Diagnosis:** chitons of small size (up to 2 cm), high-arched. Color very variable with rose, brown, and white predominating, often variegated. End valves and lateral areas of intermediate valves with radial ribs, variably granose. Central areas longitudinally ribbed, and latticed. Girdle scales, oval, only modestly convex, with shallow striae.

**Description:** Lectotype—Partly disarticulated. Length of the whole specimen (estimated) 12 mm [PALMER (1958: plt. 33, figs. 1-5) gives the length of the specimen as 14 mm]. The color of the tegmentum is a uniform light brown. Anterior valve and post-mucro area of posterior valve have distinctly granose radial ribs, well separated from each other. There are about 25 such radial ribs in valve i, and 18 in valve viii [the number of ribs is obscured by glue adhering to the valves]. In the intermediate valves, the lateral areas are distinct and bear 4-5 similar granose radial ribs. The ribs' granules are modest in size, almost obsolete at some points; they are larger, however, in the

posterior ribs, protruding discretely into the sutural spaces. Central areas have about 16 - 18 longitudinal riblets per sides, riblets that become crowded and obsolete towards the jugum to which they remain parallel. Valve ii shows a wedge figure composed of forwardly diverging jugal riblets. Cross-ribbing produces a latticing effect well marked on the pleural areas but less so at the jugum. Mucro is median, not prominent.

The articulamentum is white. Sutural laminae are semi-oval to quadrangular, relatively short. Sinus is relatively shallow; the sinus laminae show occasional irregular pectinations, and are separated from the adjacent sutural laminae by a minute notch. Teeth well cut, slightly beveled. Eaves solid. Slit formula 10-1-9. Girdle scales imbricated, oval, with about 10 shallow striae; maximum length about 200  $\mu\text{m}$ .

Another specimen (CASG 53074, coll. off Carmel, California, 9 July, 1935, at 6 fathoms, *ex* Hopkins Marine Station Collection), 12.0 mm in length, was used for SEM micrographs of the girdle scales (Figures 19, 29), and examination of the radula.

The radula measures about 7.0 mm in length, and has some 37 rows of teeth. Its relative length is 58%. The median plate is very wide anteriorly (140  $\mu\text{m}$ ) where a thin blade recurves ventrally; the plate narrows medially (to 60  $\mu\text{m}$ ), but bulges again posteriorly into a spheroid. The intermediate plate has a small knobby outgrowth in the outer-anterior corner. The uncinated plate is unicuspid; the blade measures about 200  $\mu\text{m}$  in length, the shaft about 350  $\mu\text{m}$  in length. A thick, blunt tubercle is seen on the upper part of the shaft, pointing inwardly.

The illustrated specimen, a topotype, (Figure 15, 16) of *Lepidozона sinudentata*, measures 15 mm in length, and was collected at the Breakwater, Monterey Bay, California, in 13 m of water, *leg.* A. J. Ferreira, September 1, 1973 (AJF 89).

**Individual Variation:** The considerable intraspecific variation in color and in sculpture displayed by *Lepidozона sinudentata* has left many collectors uncertain as to an understanding of the species, and bewildered by an array of names. In color, *L. sinudentata* varies from total white to dark brown, often variegated with reds, greens, oranges, sometimes even blue. Specimens of a varied color pattern may be found, and often are, side by side under

the same rock. A curious, and not uncommon color pattern, is that found on the type of *I. "gallina"* Berry, 1925, in which dark (red, maroon, or blue) transversal stripes alternate regularly with creamy-white colored ones for a zebra-like effect. It is interesting to note that there is some correlation between color pattern and depth, inasmuch as deep water specimens do not seem to vary as much in color patterns as shallow water ones do; with remarkable constancy, deep water specimens are a uniform medium brown, with no other color or pattern.

Variations in the sculpture of the radial ribs, particularly noticeable in the lateral areas have likely caused much uncertainty among collectors. As some of the illustrations here indicate (Figures 16, 17, 18), the radial ribs may vary considerably in their sculpture, boldness, number, and outline, from robustly built to absent, from coarse large granulations on the radial ribs to only minute nodules, from being well separated to being close together. In some specimens, only the granulations in the posterior rib are well marked, sometimes elongated, comma-like, protruding conspicuously into the sutural spaces; in some other specimens, the posterior rib may be non-granular, straight, or even absent. The correlation between these different forms and geography and depth is not clear cut: Northern specimens (Monterey) tend to have thicker and coarser radial ribs than southern specimens (San Diego); shallow specimens tend to have also bolder ribs in the lateral areas than deep water ones; a particular form of rib, with rather minute granules has only been found in deep water—and looked so different that for over two years, and until I examined more material from other deep water stations, I labored under the conviction of their being representatives of a new species. Variations in the central areas are not as frequent or obvious as those of the radial ribs in the lateral areas. Still, deep water specimens tend to have much more subdued longitudinal riblets, a greater number of them, more crowded together, resulting in a rather different appearance, particularly when combined with equally less marked cross-ribbing. Variation in other meristic characteristics is summarized in Table 1, based upon a random sample of 20 specimens from shallow water (down to 30 m), Monterey Bay, California.

Remarkably, the girdle scales were constant in their features in all specimens examined, despite differences in size, geography, or depth.

### Explanation of Figures 28 to 33

Figure 28: *Lepidozона pectinulata*. Girdle scales. approx.  $\times 100$

Figure 29: *Lepidozона sinudentata*. Girdle scales. approx.  $\times 200$

Figure 30: *Lepidozона willetti*. Girdle scales. approx.  $\times 1000$

Figure 31: *Lepidozона willetti*. Girdle scales. approx.  $\times 600$

Figure 32: *Lepidozона guadalupensis* Ferreira, spec. nov. Girdle scales approximately  $\times 300$

Figure 33: *Lepidozона guadalupensis* Ferreira, spec. nov. Girdle scales approximately  $\times 100$

SEM micrographs by Hans Bertsch



Figure 28



Figure 29



Figure 30



Figure 32



Figure 31



Figure 33



In size, *Lepidozonia sinudentata* only rarely attains 2 cm in length. The largest specimen examined measures 24.5 cm (including girdle) in length; its slit formula was 12-1-12 (CASIZ, Camalu, Baja California, Mexico, leg. L. D. Miles, Apr. 24, 1951, ex Miles Colln.).

**Distribution:** *Lepidozonia sinudentata* seems to have a continuous distribution between latitudes 28° N and 38° N. The northernmost record is Salt Point Ranch (38° 39' N, 123° 19' W), Sonoma County, California (LACM 64-6, at 13 m, leg. J. H. McLean, February 21, 1964). The southernmost record is Thurloe Head (27° 37' 31" N, 114° 50' 37" W), outer coast of Baja California, Mexico (LACM 71-170, 13-20 m, leg. J. H. McLean & P. LaFollette, *R/V Searcher*, October 23, 1971). There were many stations in between including collections at the offshore islands of San Geronimo (LACM 67-62), Sacramento Reef (LACM 71-91), San Martin (CASG 27600; LACM 67-60), Coronados (LACM 63-41; UCLA 22372 & 22383), San Nicolas (LACM 69-15), Catalina (UCLA 22319, 22381 & 22386; LACM 65-6; LACM-AHF 1359-41, 1381-41, 1399-46, 1426-41 & 1624-48; CASG 41308), Santa Rosa (LACM 73-9), Santa Cruz (LACM 63-5 & 73-11; LACM-AHF 1286-41), San Miguel (LACM 67-38) and Farallon (LACM 62-9).

Bathymetrically, *Lepidozonia sinudentata* has been found from intertidal to about 200 m (LACM-AHF 1359-41, "100-108 fathoms, on gray sand, 1¾ miles east of White Cove, Santa Catalina Island, Los Angeles, California . . . June 13, 1941," 1 specimen).

**Remarks:** The marked variability in *Lepidozonia sinudentata* deserves emphasis. Interesting is the color phase "gallina" with its zebra-like appearance. Color variation in chitons is found in many species, but this particular zebra pattern is uncommon. However, it may be seen in two other species not immediately related: *Ischnochiton petalooides* (Gould, 1846) [= *I. mariposa* Dall, 1919] from the eastern Pacific and *Ischnochiton zebrinus* Berghenayn, 1933 from the Sea of Japan.

But the variations in sculpture, particularly of the lateral areas, should be stressed inasmuch as they may cause, and likely have caused, the false impression of distinct species. The deep water specimens may be particularly troublesome. It was only when, thanks to the kindness of Dr. James H. McLean, I had the opportunity of examining material in the Allan Hancock Foundation Collection, now with the Los Angeles Museum of Natural History, from several deep-water stations in the general area of Catalina Island, Los Angeles County, California (LACM-AHF 1259-41, 1286-41, 1359-41, 1381-41, 1383-41, 1426-41, 1399-46, 1624-48), that I realized the full

scope of intraspecific variation in *L. sinudentata*, and was led to adopt an even broader view of the species than, under the auspices of A. G. Smith, I had anticipated.

*Lepidozonia scabricostata* (Carpenter, 1864)

(Figures 7, 8, 24, 25)

- Ischnochiton (Lepidopleurus) scabricostatus* CARPENTER, 1864b: 612 (Reprinted, 1872: 98), *nomen nudum*; A. G. SMITH, 1977: 216, 234-235
- Lepidopleurus scabricostatus* CARPENTER 1864b: 649 (Reprinted, 1872: 135); 1866: 212; COOPER, 1867: 22; LOWE, 1904: 19 [in error as "*crebriostatus*"]
- Ischnochiton (Ischnochiton) scabricostatus*, PILSBRY, 1892, 14: 121; 1893, 15: 76, pl. 16, figs. 55, 56; DALL, 1921: 191; A. G. SMITH, 1947: 18
- Ischnochiton scabricostatus*, PILSBRY, 1896: 49-50; 1898: 288; KEEP, 1904: 349; OLDROYD, 1927: 276; PALMER, 1945: 101 [as "*I. subexpressus* Cpr. type = *scabricostatus* Cooper No. 518a . . ."]; 1958: 296; pl. 30, figs. 10-12; BURGHARDT & BURGHARDT, 1969: 18; ABBOTT, 1974: 395
- Ischnochiton (Lepidozonia) golischi* BERRY, 1919, 2 (6): 7; 1925, 16 (5): 229-231; pl. 11, figs. 3, 4; A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948: 207-208 [in error for *I. (L.) gallina* Berry, 1925]; A. G. SMITH, 1977: 216, 226 (syn. of *L. scabricostata*)
- Ischnochiton (Ischnochiton) golischi*, DALL, 1921: 192 (in section *Lepidozonia*)
- Ischnochiton golischi*, OLDROYD, 1927: 284 (in section *Lepidozonia*); TALMADGE, 1973: 232
- Lepidozonia golischi*, BURGHARDT & BURGHARDT, 1969: 21-22; ABBOTT, 1974: 396, fig. 4647
- Lepidozonia inefficax* BERRY, 1963: 138; ABBOTT, 1974: 396

**Nomenclatural Comments:** CARPENTER'S (1864b) original description of *Ischnochiton scabricostatus* was both inadequate and confusing. PILSBRY'S (1893, 15: 76; pl. 16, figs. 55, 56) redescribed and figured the species based upon the only specimen known at the time (USNM 16268). Still, the difficulties remained, and in collections specimens were often found labelled as *Ischnochiton (Lepidozonia) golischi* Berry, 1919. Examination of the holotype of *Ischnochiton scabricostatus* Carpenter, 1864, made available through the courtesy of Dr. Joseph Rosewater, United States National Museum, Washington, D.C., solved conclusively the identification problem. A specimen (ANSP 72128) subsequently reported and labelled as *Ischnochiton scabricostatus* by PILSBRY (1898: 288) loaned for study through the kindness of Dr. Robert Robertson, Academy of Natural Sciences, Philadelphia, confirmed the correctness of its synonymy with the later-named *I. golischi*. The examination of the holotype of *Ischnochiton (Lepidozonia) golischi* Berry, 1919, and the only extant paratype of *Lepidozonia inefficax* Berry, 1963, made available through the generous hospitality and cour-

tesy of Dr. S. Stillman Berry, Redlands, California, September 21, 1974, revealed their conspecificity with *Lepidozonia scabricostata*.

**Diagnosis:** Chitons of small size (up to about 2 cm), high arched. Color uniform, orange-brown to creamy-white. End valves and lateral areas display flattish radial ribs, neatly separated by sulci, and bearing a row of small round tubercles (often eroded away). Central areas with longitudinal riblets with a tendency to become beaded, and only faintly latticed. Girdle scales imbricated, moderately convex, shallowly striated.

**Type Material:** Holotype (USNM 16268), figured in PILSBRY (1893, 15: pl. 16, figs. 55, 56) and PALMER (1958: pl. 30, figs. 10 - 21); color slides at CASIZ, Nos. 2974-77 (A. G. Smith), and 3119 (AJF). Other type material deposited by Carpenter in the "State Collection, no. 1071 c" [which refers to the old California State Collection] is presumed lost.

*Ischnochiton (Lepidozonia) golischi* Berry, 1919: "Type—An animal preserved dry [S.S.B. 1068], entered as Cat. No. 4093 of the author's collection. A paratype [S.S.B. 1067] is the property of the Southwest Museum, Los Angeles." (BERRY, 1925: 230).

*Lepidozonia inefficax* Berry, 1963: Holotype, "No. 28,712 Berry Collection", has been lost (Dr. S. S. Berry, personal communication, Sept. 21, 1974). One paratype, still attached to the shell of the brachiopod *Terebretalia*, in the Berry Collection; color slides of the paratype at CASIZ, Nos. 3115-16 (AJF).

**Type Locality:** "Catalina Island [California] 10 - 20 fms. . . ." [18 - 36 m] (CARPENTER, 1866: 212).

**Description:** The specimen [not figured here] is oval, high arched, carinated, uniformly brown in color. Fully extended, preserved in ethyl alcohol, it measures 21.5 mm in length (including girdle), 12.0 mm in width, and 3.5 mm in height. Width/length ratio: 0.55. Jugal angle about 93°.

The anterior valve displays about 40 flat radial ribs separated from each other by a shallow sulcus, and bearing a row of small (about 100 µm in diameter) round tubercles. Most of these tubercles are missing, obviously eroded away; but it may be estimated that there would be about 12 per rib. The posterior valve shows about 30 of such tuberculated ribs in the post mucro area. The lateral areas of the intermediate valves are well defined; they bear 6 - 7 similar flat, tuberculated ribs, many of the tubercles missing. Central areas have about 24 longitudinal riblets per side, with rather faint cross-ribbing; the longitudinal riblets tend to become obsolete towards the jugum, and often

are definitely granular, quasi-beaded. The jugal tract diverges forwardly on valve ii, outlining a wedge-like figure. Mucro is moderately anterior.

The gills, about 30 on each side, extend from about 1 mm in front of the anus to 2 mm behind the anterior border of the foot. The girdle, about 1.5 mm in width, is covered by imbricating, oval, flattish, scales, measuring as much as 220 µm in length, and displaying some 10 - 12 shallow striations.

The specimen, a topotype, was collected off Empire Landing, Catalina Island (33°26'N, 118°29'W), California, in 79 m of water [43 fathoms] (CASIZ, leg. D. P. Abbott, Feb. 9, 1949, ex R. Stohler). Color slides at CASIZ, No. 590.

A second specimen collected at 365 - 730 m [200 - 400 fathoms] off Cordell Bank (38°03'N, 123°32'W), California (CASG 43983, *USS Mulberry*, station 56, March 29, 1950) is illustrated here (Figures 7, 8).

A third specimen collected at 365 m [200 fathoms] off False Cape (40°31'N, 124°24'W), Humboldt County, California, (CASIZ, *M/V Flicker*, Sept. 1967, ex R. R. Talmadge) measures 22.9 mm in length, and was used for the study of the articulamentum, radula, and SEM micrographs of the girdle scales (Figures 24, 25).

The articulamentum of this specimen is white. Sutural laminae are sharp and semioval, separated by a relatively shallow sinus. The sinus laminae are irregularly pectinated, and demarcated from the adjacent sutural laminae by a minute notch. Eaves are solid. The teeth are sharp edged and straight. Slit formula 12-1-11.

The radula measures 8.4 mm in length, and has 38 rows of teeth. Radula relative length 37%. The median plate is enlarged anteriorly (130 µm), where it bears a thin blade recurved ventrally; it narrows medially but only moderately (to about 50 µm); posteriorly it bulges again (to about 80 µm) in a spheroid. The intermediate plates have a knobby outgrowth at the outer-anterior corner. The uncinated plate is unicuspid; the blade measures about 180 µm in length, the shaft 600 µm. No tubercle is seen in the upper part of the shaft or the uncinated plate, nor in the radula of another specimen examined from the same station.

**Individual Variation:** All specimens tend to be uniformly colored. Some were an intense orange "Caledonian" brown, others a much lighter color, almost white. Variations in meristic characteristics are summarized in Table 1. The largest specimen examined measures, including the girdle, 24 mm in length (CASIZ, off Point Joe, Monterey Peninsula, Monterey County, California, in 110 - 130 m of water [60 - 70 fathoms], leg. C. Jones, May 1941, ex Wilfred Mack Colln.).



Table 1

	<i>Lepidozonia mertensii</i> (n=20)	<i>Lepidozonia cooperi</i> (n=20)	<i>Lepidozonia pectinulata</i> (n=20)	<i>Lepidozonia sinuidentata</i> (n=20)	<i>Lepidozonia scabricostata</i> (n=12)	<i>Lepidozonia willetti</i> (n=10)	<i>Lepidozonia vetiporosa</i> (n=20)	<i>Lepidozonia guadalupensis</i> (n=12)
length (mm)	30-42	18-42	17-39	13-22	10-24	10-20	8-17	12-25
width (mm)	16-21	10-22	9-20	8-12	7-13	4-10	5-11	9-15
width/length ratio (mean)	0.59	0.57	0.58	0.56	0.58	0.61	0.61	0.63
jugal angle (mean)	93°	92°	99°	92°	98°	99°	99°	104°
Tegmentum:								
Valve i-ribs (no.)	21-40	15-24	16-35	18-29	32-50	20-40	20-30	12-26
(mean)	27.7	21.0	24.5	22.5	40.0	29.8	25.5	18.3
Valves ii-vii								
central areas								
riblets (no.)	10-14	10-22	13-20	13-19	19-22	16-22	30-40+	11-16
latticed?	yes	yes	yes	yes	yes	yes	yes "pitted"	yes
"wedge" on ii?	yes	yes	yes	yes	yes	yes	no	yes
lateral areas								
ribs (no.)	5-8	3-8	4-6	3-5	4-7	4-7	3-6	3-6
(mode)	6	5	4	4	5	5	5	4
(sculpture?)	tubercles round (200 μm)	tubercles elongated	granular	granose (variably)	tubercles round (100 μm)	tubercles round (100 μm)	tubercles round (80 μm)	tubercles round (200 μm)
Valves viii-ribs (no.)	11-23	15-20	12-30	12-27	25-40	15-28	15-20	13-20
(mean)	17.5	16.7	20.3	16.8	30.0	21.0	17 ?	15 ?
muco?	ant./cent.	cent.	cent.	cent.	ant.	ant.	ant.	ant./cent.
Articulamentum:								
Valve i-slits (no.)	8-12	9-15	10-15	7-11	10-13	10-11	8-13	9-11
(mode)	10	10	12	9	12	10	11	11
Valve viii-slits (no.)	8-11	9-14	10-17	7-11	11-14	9-11	8-12	9-11
(mode)	10	10	15	9	11	10	10	11
Girdle scales:								
flat-striated (S) or								
convex mammillated (M)?	M	S	M	S	S	M	S	M
maximum length (μm)	500	500	400	300	250	400	200	500

In some specimens the longitudinal riblets of the central areas are definitely granose to beaded. Some specimens display also what could be called growth lines in the form of transversal rugae particularly noticeable on valve ii.

**Distribution:** *Lepidozonia scabricostata* appears to have a continuous distribution between the latitudes 28° N and 48° N. The northernmost record is Cape Flattery (48° 24.7' N, 126° 06.2' W), Washington (LACM 72-140, FRB sta. 72-Q-3, at 274 m, leg. D. Quayle, Feb. 1972). The southernmost record is that given by BERRY (1963) for *L. "inefficax"*, Sebastian Vizcaino Bay (28° 26.5' N, 114° 36' W) Baja California, Mexico, at 55-57 fathoms [99-103 m]. There are many stations between these extremes. Although it has been found intertidally (LACM 63-53, Ensenada, Baja California, leg. J. H. McLean, Nov. 29, 1963, 12 specimens), *L. scabricostata* is confined to relatively deep water. Records from the offshore island

are as follows: San Clemente (LACM-AHF 911-39, at 60-85 fathoms [108-153 m]), San Nicolas (LACM-AHF 1345-41, at 57 fathoms [103 m]), Catalina LACM-AHF 3310-55, at 47-52 fathoms [85-94 m]; UCLA 22403, at 40 fathoms [72 m]), Santa Rosa (LACM-AHF 1385-41, at 75-76 fathoms [135-137 m]). Santa Cruz (LACM-AHF 1196-40, at 110-140 fathoms [198-252 m]), and Anacapa (LACM-AHF 874-38, 45 fathoms [81 m]). The greatest depth at which the species has been found is 1260-1460 m [690-800 fathoms] (CASG 43981, Mulberry Seamont, USS Mulberry station 38, February 13, 1950).

**Remarks:** There is a great similarity between *Lepidozonia scabricostata* and *L. willetti* (Berry, 1917). The two species seem to agree in almost every respect except their radically different girdle scales. To make the matter all the more interesting, the two species are sympatric, often being found together in the same station, and exhibiting

exactly the same golden brown color. Both *L. scabricos-tata* and *L. willetti* differ from *L. mertensii* in several respects, above all by their girdle scales, the presence of sulci between the radial ribs, and the size of the tubercles on those ribs. From the examination of specimens of comparable size, it was learned that the tubercles of *L. scabricos-tata*, as well as those of *L. willetti*, measure about 100  $\mu\text{m}$  in diameter whereas those of *L. mertensii* averaged 200  $\mu\text{m}$  in diameter.

*Lepidozона willetti* (Berry, 1917)

(Figures 9, 10, 30, 31)

*Ischnochiton (Lepidozона) willetti* BERRY, 1917: 232, 236-238, figs. 1, 2; A. G. SMITH, 1977: 216, 238

*Ischnochiton willetti*, WILLETT, 1919: 27; OLDROYD, 1924: 192-193; LAROCQUE, 1953: 13 (in section *Lepidozона*)

*Ischnochiton (Ischnochiton) willetti*, DALL, 1921: 192 (in section *Lepidozона*)

*Lepidozона willetti*, BURGHARDT & BURGHARDT, 1969: 23; ABBOTT, 1974: 395

*Ischnochiton (Lepidozона) catalinae* WILLETT, 1941: 185-186; pl. 31, fig. 2; A. G. SMITH, 1947: 18; A. G. SMITH & GORDON, 1948: 207 [error in identification, A. G. SMITH, 1977: 222]; A. G. SMITH, 1977: 216, 222 (syn. of *L. willetti*)

*Lepidozона catalinae*, BURGHARDT & BURGHARDT, 1969: 20-21; ABBOTT, 1974: 396

**Nomenclatural Comments:** The conspecificity of *Lepidozона willetti* and *L. catalinae* was established through the examination and side by side comparison of type materials of both nominal species, namely, *L. willetti*, paratype (UCLA 22314) available through the courtesy of Dr. W. P. Popenoe and Mrs. LouElla Saul, University of California, Los Angeles; *L. willetti* virtual paratype (CASG 43991) through the cooperation of Dr. Peter U. Rodda, California Academy of Sciences, Department of Geology, San Francisco; and *L. catalinae* holotype (LACM 1063), through the kindness of Dr. James H. McLean, Los Angeles County Museum of Natural History, Los Angeles, California.

**Diagnosis:** Chitons of medium size (up to 3 cm), oval, high arched. Uniformly colored reddish-brown. End valves and lateral areas show flattish radial ribs separated by sulci, and bearing small round tubercles. Central areas with longitudinal riblets, often faintly beaded, and weakly latticed. Mucro is anterior. Girdle with imbricated, strongly convex scales bearing a rather long, striated, mammilla.

**Type Material:** Holotype - "A shell preserved dry [S.S.B 159] as Cat. No. 3700 in the author's collection". (BERRY, 1917: 238). Paratypes - "... in the collections of the California Academy of Sciences [CASG 1123], the Academy of Natural Sciences of Philadelphia [ANSP 117530], the United States National Museum [USNM 217936], and the private collection of Mr. George Willett [UCLA 22314]" (BERRY, l.c.).

*Ischnochiton (Lepidozона) catalinae* Willett, 1941: Holotype (LACM 1063). Paratypes (UCLA 22320 ex G. Willett Colln.; LACM 1000; CASG 10263 ex A. G. Smith Colln.; ANSP 117536).

**Type Locality:** "15 - 20 fathoms [27 - 36 m], Forrester Island, Alaska; George Willett, May-July-August, 1914 - 1916; 36 specimens." (BERRY, l.c.)

**Description:** BERRY's (1917) original description and figuring is perfectly adequate to define and understand the species.

The photographed specimen (Figures 9, 10) is a paratype (CASG 1123). Color slide at CASIZ, No. 3101 (AJF). It shows that the longitudinal riblets in the central area remain parallel to the jugum or even display a mild tendency to converge forwardly. However, the jugal tract supersedes them on valve ii where it diverges forward widely forming a wedge-like figure. The tubercles of the radial ribs measure about 100 - 150  $\mu\text{m}$  in diameter and height. The girdle scales, strongly convex and with long nipples measure a maximum of 270  $\mu\text{m}$  in length. Mucro is anterior.

Another specimen (SDNH 23505), a topotype, was used for color slides of the girdle scales, now at CASIZ, Nos. 3126-27 (AJF).

A third specimen was used to obtain SEM micrographs of the girdle scales (Figures 30, 31), and study of the radula. The specimen, dried but fully extended measures 16.5 mm in length (CASG 32536, San Pedro, California, San Diego Marine Biology Association sta. no. XXI-2, at 79 - 140 m, June 20, 1901). Slit formula 10-1-10.

The radula of this specimen measures 6.3 mm in length, and has 38 rows of teeth. Relative length 38%. The median plate is wide anteriorly (140  $\mu\text{m}$ ) with a thin blade that recurves ventrally; the plate narrows medially (to 50  $\mu\text{m}$ ) and then bulges posteriorly (to 80  $\mu\text{m}$ ) to terminate abruptly in a point. The intermediate plate shows a knobby outgrowth on the outer-anterior corner. The uncinated plate is unicuspid; the blade is about 250  $\mu\text{m}$  in length, the shaft 500  $\mu\text{m}$ . A tubercle is discernible on the